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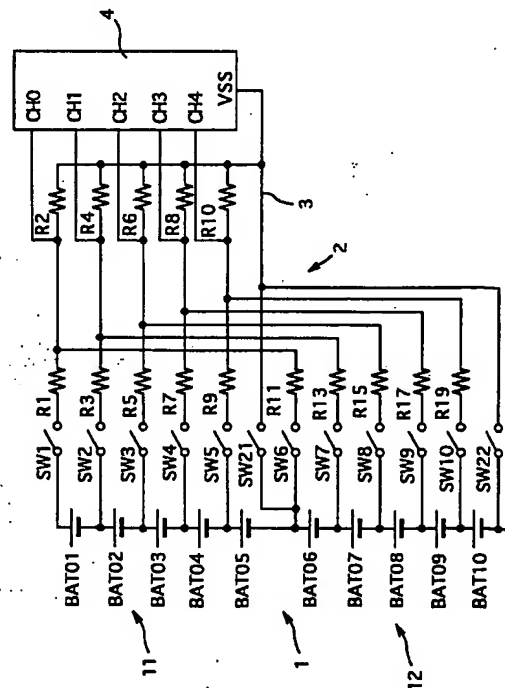
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(54) 【発明の名称】 組み電池の電圧検出装置

## (57) 【要約】

【課題】 検出精度や安全性の低下を抑止しつつ簡素な回路構成で実現できる組み電池の電圧検出装置を提供すること。

【解決手段】 電池ブロック11の最低位の端子からなる共通端子は、それぞれ複数の抵抗素子R1～R10を直列接続してなる多数の分圧回路の一端に基準電位ライン3を通じて個別に接続され、各分圧回路の他端は、この共通端子を除く各電池モジュールBAT01～BAT05の高位側の端子にそれぞれ接続され、各分圧回路の複数の抵抗素子のうち、基準電位ライン側の抵抗素子R2、R4、R6、R8、R10の電圧降下が検出される。更に、基準電位ライン側の抵抗素子R2、R4、R6、R8、R10は、電池ブロック12の電池モジュールBAT06～BAT10の電位を検出する分圧回路の基準電位ライン側の抵抗素子を兼ねる。



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## 【特許請求の範囲】

【請求項1】電池モジュールを複数直列接続してなる電池ブロックを複数直列接続してなる組み電池から各前記電池モジュールの端子電圧をモジュール電圧検出部により検出する組み電池の電圧検出装置において、前記電池ブロックの最高位または最低位の端子からなる共通端子は、それぞれ複数の抵抗素子を直列接続してなる多数の分圧回路の各一端である共通接続端に基準電位ラインを通じて接続され、各前記分圧回路の他端は、前記共通端子を除く各前記電池モジュールの端子にそれぞれ接続され、前記モジュール電圧検出部は、前記各分圧回路の前記複数の抵抗素子のうち、前記基準電位ライン側の前記抵抗素子の電圧降下を検出することを特徴とする組み電池の電圧検出装置。

【請求項2】請求項1記載の組み電池の電圧検出装置において、電位的に隣接する第一、第二の前記電池ブロックの前記共通端子は、それぞれ切り替えスイッチを通じて共通の前記基準電位ラインに接続され、前記各分圧回路は、それぞれ前記複数の抵抗素子と直列接続された切り替えスイッチを有し、前記第一の電池ブロックの前記基準電位ライン側の前記抵抗素子は、前記第二の電池ブロックの前記基準電位ライン側の前記抵抗素子を兼ねることを特徴とする組み電池の電圧検出装置。

【請求項3】請求項1又は2記載の組み電池の電圧検出装置において、前記各分圧回路は、それぞれ前記複数の抵抗素子と直列接続された切り替えスイッチを有し、前記基準電位ライン側の前記抵抗素子は、前記各分圧回路において共通とされることを特徴とする組み電池の電圧検出装置。

【請求項4】請求項2又は3記載の組み電池の電圧検出装置において、前記各切り替えスイッチは前記分圧回路の前記複数の抵抗素子の間に介設され、複数の前記切り替えスイッチは同一回路モジュールに集積されることを特徴とする組み電池の電圧検出装置。

【請求項5】請求項1記載の組み電池の電圧検出装置において、電位的に隣接する第一、第二の前記電池ブロックの前記共通端子は、それぞれ切り替えスイッチを通じて共通の前記基準電位ラインに接続され、前記各分圧回路は、それぞれ前記複数の抵抗素子と直列接続された逆流防止ダイオードを有することを特徴とする組み電池の電圧検出装置。

【請求項6】請求項5記載の組み電池の電圧検出装置において、電位的に隣接して直列接続された一対の前記電池ブロッ

クのうちの高位側の前記電池ブロックに属する前記電池モジュールに接続される前記分圧回路の分圧出力端の電位を所定レベル以下に抑止するクランプ回路を備えることを特徴とする組み電池の電圧検出装置。

【請求項7】請求項5記載の組み電池の電圧検出装置において、複数の前記分圧回路の分圧出力端は互いに異なる信号切り替えスイッチを通じて一つの前記電圧検出回路の入力端に接続されることを特徴とする組み電池の電圧検出装置。

## 【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、組み電池の電圧検出装置に関する。

【0002】

【従来の技術】特開平5-64377号公報は、縦続接続形式の多数の単電池からなる複数の電池モジュールのモジュール電圧をそれぞれ電圧検出モジュールで検出する組み電池の電圧検出装置を提案している。

【0003】

【発明が解決しようとする課題】しかしながら、上述したように各モジュール電圧を多数の差動型電圧検出回路で個別に検出することは、回路構成が大規模となり、費用、電力消費、スペース、信頼性の点で改善を要していた。

【0004】本発明は上記問題点を鑑みなされたものであり、検出精度や安全性の低下を抑止しつつ簡素な回路構成で実現できる組み電池の電圧検出装置を提供することを、その目的としている。

【0005】

【課題を解決するための手段】請求項1に記載した本発明の組み電池の電圧検出装置によれば、高圧の組み電池は、電池モジュールを複数直列接続してなる電池ブロックを複数直列接続してなる。電池モジュールとしては単電池を一個もちいてもよく、複数の単電池を直列接続してもよい。

【0006】本構成では特に、電池ブロックの最高位または最低位の端子からなる共通端子は、それぞれ複数の抵抗素子を直列接続してなる多数の分圧回路の一端に基準電位ラインを通じて個別に接続され、各分圧回路の他端は、共通端子を除く各電池モジュールの端子にそれぞれ接続され、各分圧回路の複数の抵抗素子のうち、基準電位ライン側の抵抗素子の電圧降下が検出される。このようにすれば、同一の電池ブロック内の各分圧回路からモジュール電圧検出部に出力される分圧からなるモジュール電圧信号は、基準電位ラインの電位からなる共通電位を基準とする電位信号となるので、その後の回路処理が簡単となり、簡素な回路構成で誤差が少ないモジュール電圧検出をおこなうことができる。

【0007】更に説明すると、一つの電池ブロックにお

いて、各電池モジュールの電位がこの電池ブロックの最高電位または最低電位を基準として検出されるので、各電池モジュールの端子電圧は、検出された各電池モジュール電位の差分として求められる。このようにすれば、各電池モジュールの電位差（端子電圧）を個別に検出するよりも、各モジュール電圧検出部に印加する電源電圧を共用化することができるので、電源回路の簡素化を図ることができ、各電源回路から出力される電源電圧変動のばらつきの影響も小さい。

【0008】ただし、上述した電池ブロックごとに共通の基準電位からの電位差で各電池モジュールの電位を求め、各電池モジュールの電位の減算で各電池モジュールの電位差を算出する方式では、電池ブロックの基準電位ラインから離れた電池モジュールの電位が電池モジュール電位差の数倍たとえば数十Vといった高圧となり、このような高電圧の検出のためにモジュール電圧検出部の入力部の耐圧増大を必要とする。これに対し、本構成では、上記基準電位ラインの電位（基準電位）を基準とする分圧回路で各電池モジュールの電位を分圧しているので、モジュール電圧検出部の入力電圧をたとえば5Vと

【0009】請求項2記載の構成によれば請求項1記載の組み電池の電圧検出装置において更に、電位的に隣接する第一、第二の電池ブロックの前記共通端子はそれぞれ切り替えスイッチ（基準電位切り替えスイッチ）を通じて共通の前記基準電位ラインに接続され、各分圧回路はそれぞれ複数の抵抗素子と直列接続された切り替えスイッチ（モジュール電圧切り替えスイッチ）を有し、第一の電池ブロックの基準電位ライン側の抵抗素子は第二の電池ブロックの基準電位ライン側の抵抗素子を兼ねる。

【0010】このようにすれば、電位的に隣接する一对の電池ブロックの電位を切り替えスイッチの切り替えにより検出することができるので、モジュール電圧検出部の数を半減できるとともに、分圧回路の抵抗素子の必要個数を大幅に減らすことができ、回路規模の縮小を図ることができる。

【0011】更に、互いに接続された複数のモジュール電圧切り替えスイッチの一つが短絡故障した状態で、残りのモジュール電圧切り替えスイッチをオンしても、これら両切り替えスイッチを経由して流れる短絡電流は抵抗素子により抑制されるので安全性に優れる。すなわち、分圧回路の抵抗は請求項1記載の作用効果を奏すると同時に短絡電流低減効果も奏することができる。

【0012】請求項3記載の構成によれば請求項1又は2記載の組み電池の電圧検出装置において更に、各分圧回路はそれぞれ複数の抵抗素子と直列接続された切り替えスイッチを有し、基準電位ライン側の抵抗素子は各分圧回路において共通とされる。

【0013】このようにすれば、更にモジュール電圧検出部および分圧回路の抵抗素子の必要数を削減することができるので、更なる回路規模縮小を実現することができる。

【0014】請求項4記載の構成によれば請求項2又は3記載の組み電池の電圧検出装置において更に、各切り替えスイッチは分圧回路の複数の抵抗素子の間に介設され、複数の切り替えスイッチは同一回路モジュールに集積されるので、回路構成の簡素化を図ることができる。

【0015】すなわち、各切り替えスイッチを分圧回路の複数の抵抗素子の間に介設する場合、各切り替えスイッチの反電池モジュール側の端子は少なくとも一つの他の切り替えスイッチの反電池モジュール側の端子と回路モジュール内部で結線することができるので、外部の配線ライン数およびその結線作業を大幅に低減することができ、切り替えスイッチ回路を簡素化することができる。

【0016】請求項5に記載した本発明の組み電池の電圧検出装置によれば、電位的に隣接する第一、第二の電池ブロックの共通端子はそれぞれ切り替えスイッチを通じて共通の基準電位ラインに接続され、各分圧回路は複数の抵抗素子（分圧抵抗）と直列に接続された逆流防止ダイオードを有する。電圧検出回路は、測定すべき電池ブロックの最低電位の電池モジュールの低電位端を実質的に基準としてこの電池ブロックに属する各抵抗分圧回路の分圧出力端の電位を検出する。この時、測定すべき電池ブロックの共通端子は測定時にのみ切り替えスイッチで基準電位ラインに接続される。

【0017】このようにすれば、以下の作用効果を奏する。

【0018】本構成によれば、電池モジュールと抵抗分圧回路との間に各抵抗分圧回路ごとに逆流防止ダイオードを介設するので、請求項2記載の構成のように各分圧回路ごとに切り換えスイッチを直列接続する必要がなく、回路製造が簡単となる。

【0019】すなわち、この逆流防止ダイオードは、請求項3記載の構成のように各分圧回路ごとに設けた切り換えスイッチにより任意の二つの分圧回路及び1乃至複数の電池モジュールからなる回路を循環する循環（短絡）電流を阻止することができる。逆流防止ダイオードは切り換えスイッチに比較して格段に安価であり、かつその開閉制御回路も省略することができる。

【0020】更に説明する。

【0021】この切り換えスイッチは分圧回路と直列に接続されるので、分圧回路の電流が流れる。周知のように電池モジュールの電圧変化は小さく、この小電圧変化を極めて低ノイズに測定する必要があるため、分圧回路の抵抗素子（及びそれと切り替えスイッチを直列接続する場合にはそのオン抵抗）を小さくして、それらの抵抗性雑音を小さくする必要がある。

【0022】しかし、切り換えスイッチはいわゆるトランスファスイッチであり、安全上両方向の耐圧をそれぞれ確保する必要があり、バイポーラ技術で作成することが難しく、MOS技術で作製せざるを得ない。しかしながら、切り換えスイッチとしての大型のMOSトランジスタと分圧回路の低抵抗素子（通常、バイポーラ技術で作製される）との集積化は容易ではない。

【0023】これに対し、本構成では必要な切り換えスイッチの個数が少なく、短絡電流阻止のために逆流防止ダイオードを用いる構成を採用するので、低抵抗の分圧回路とこの逆流防止ダイオードとはバイポーラ集積回路技術により簡単に集積化することができる。

【0024】なお、本回路構成によれば、電圧検出回路は、（電池モジュールの端子電圧 $V$ -逆流防止ダイオードの順方向電圧降下 $\Delta V$ ） $\times$ 分圧比に等しい信号電圧を測定するが、電流値や温度がわかれば逆流防止ダイオードの順方向電圧降下量は予め知ることができるので、種々のハードウェア又はソフトウェアを用いて逆流防止ダイオードの電圧降下のばらつきによる測定値を補正することができる。

【0025】請求項6記載の構成によれば請求項5記載の組み電池の電圧検出装置において更に、電位的に隣接して直列接続された一対の前記電池ブロックのうちの高位側の電池ブロックに属する電池モジュールに接続される分圧回路の分圧出力端の電位を所定レベル以下に抑止するクランプ回路を備える。

【0026】このようにすれば、クランプ回路の作動により、低位側の電池ブロックに属する電池モジュールに接続される抵抗分圧回路の分圧出力端の電位を測定する際に、低位側の電池ブロックの電圧分に分圧回路の分圧比を掛けた電圧だけ高位側の電池ブロックの抵抗分圧回路の出力がレベルアップすることがなく、その電圧を検出するモジュール電圧検出部の入力耐圧を増大する必要がない。

【0027】なお、このクランプ回路としては、ダイオードや定電圧ダイオードなどを用いることができる。

【0028】請求項7記載の構成によれば請求項5記載の組み電池の電圧検出装置において更に、複数の分圧回路の分圧出力端は互いに異なる信号切り替えスイッチを通じて一つの電圧検出回路の入力端に接続される。

【0029】このようにすれば、低位側の電池ブロックに属する電池モジュールに接続される分圧回路の分圧出力端の電位を測定する際に、低位側の電池ブロックの電圧分に分圧回路の分圧比を掛けた電圧だけ高位側の電池ブロックの抵抗分圧回路の出力がレベルアップしても、上記信号切り替えスイッチが開放されているので、高位側の電池ブロックに属する電池モジュールに接続される分圧回路の分圧出力端の電位を検出するモジュール電圧検出部の入力信号耐圧を増大する必要がなく、上記クランプ回路を省略することができる。

【0030】更にその上、この信号切り替えスイッチは、いわゆるマルチプレクサとして用いることができ、モジュール電圧検出部の個数を減らすことができるという利点がある。

【0031】なお、この回路構成は、逆流防止ダイオードと信号切り替えスイッチとを両方必要とするが、この信号切り替えスイッチは、請求項2記載するような分圧回路と直列接続された切り替えスイッチとは本質的に異なり、そのオン抵抗は格段に高くてもよい。すなわち、この信号切り替えスイッチは単に分圧回路の分圧出力端の電位をモジュール電圧検出部の入力端に伝達すればよく、そのオン抵抗はたとえば数 $k\Omega$ 以上としても問題がなく、多数の信号切り替えスイッチをMOS集積回路で容易に構成でき、更にこの程度のオン抵抗値はモジュール電圧検出部の入力端へのサージノイズ電圧侵入を抑止するので好ましい。

【0032】これに対し、分圧回路と直列接続された切り替えスイッチは、抵抗性ノイズ電圧を抑止するためにそのオン抵抗を格段に低抵抗化しなければならず、多数の切り替えスイッチを集積することは困難であり、その上、オン抵抗のばらつきも減らす必要もある。

【0033】

【発明の実施の形態】以下、本発明の好適な態様を以下の実施例により詳細に説明する。ただし、本発明は下記の実施例の構成に限定されるものではなく、置換可能な公知回路を用いて構成できることは当然である。

【0034】

【実施例1】本発明の組み電池の電圧検出装置の一実施例を図1に示す部分回路図を参照して説明する。

【0035】1は組み電池であり、最高位の電池ブロック11、次に最高位の電池ブロック12を含む合計4個の電池ブロックを直列接続してなる。ただし、残りの電池ブロックの図示は省略する。電池ブロック11は5つの電池モジュールBAT01～BAT05を直列接続してなり、電池ブロック12は5つの電池モジュールBAT06～BAT10を直列接続してなる。

【0036】2は、抵抗素子R1～R11、R13、R15、R17、R19からなる分圧回路群であり、R1及びR2、R3及びR4、R5及びR6、R7及びR8、R9及びR10、R11およびR2、R13及びR4、R15及びR6、R17及びR8、R19及びR10はそれぞれ分圧回路を構成している。抵抗素子R2、R4、R6、R8、R10（本発明でいう基準電位ライン側の抵抗素子）の各一端は、基準電位ライン3及び切り替えスイッチSW21を通じて電池ブロック11の最低電位端に接続され、かつ、基準電位ライン3及び切り替えスイッチSW22を通じて電池ブロック12の最低電位端に接続されている。また、抵抗素子R2、R4、R6、R8、R10（本発明でいう基準電位ライン側の抵抗素子）の各他端は、抵抗素子R1、R3、R5、R

7、R9及び切り替えスイッチSW1～SW5を通じて、電池ブロック11の各電池モジュールの高位側の極に接続されている。更に、抵抗素子R2、R4、R6、R8、R10（本発明でいう基準電位ライン側の抵抗素子）の各他端は、抵抗素子R11、R13、R15、R17、R19及び切り替えスイッチSW6～SW10を通じて、電池ブロック12の各電池モジュールの高位側の極に接続されている。

【0037】各切り替えスイッチSW1～SW10、SW21、SW22は、フォトMOSトランジスタからなり、それぞれ対面するLEDからの光信号により駆動されて開閉される。

【0038】4はモジュール電圧検出ブロックであり、内部に5チャンネルのモジュール電圧検出部を並列に内蔵しており、抵抗素子R2、R4、R6、R8、R10（本発明でいう基準電位ライン側の抵抗素子）の電圧降下を個別に検出している。上記モジュール電圧検出部はそれぞれA/Dコンバータからなる。もちろん多数の入力信号を逐次切り替える形式のA/Dコンバータを用いてもよい。

【0039】このA/Dコンバータは、上記各分圧回路から入力される分圧と基準電位VSSとの電圧差をデジタル信号に変換する。一例において、このA/Dコンバータは、基準電位VSSを基準電位としてそれより大きい各種の参照電圧を作成する参照電圧発生回路と、作成された各参照電圧と入力される分圧とを比較する複数のコンパレータと、コンパレータから出力される信号をデジタル信号に変換するデジタル信号発生回路とを有するが、詳細説明は省略する。

【0040】電池ブロック11の電池モジュールの電圧検出時には、A/Dコンバータは基準電位ライン3および切り替えスイッチSW21を通じて電池モジュールBAT05の低位側の極から基準電位VSSを受け取り、この時、切り替えスイッチSW22は開放されている。これにより、切り替えスイッチSW1～SW5をオンし、切り替えスイッチSW6～SW10をオフすることにより、電池ブロック11の各電池モジュールBAT01～BAT05の高位側の極の電位がデジタル信号に変換されて図示しないコントローラに出力され、このコントローラが減算処理により各電池モジュールBAT01～BAT05の電圧を検出する。

【0041】同様に、電池ブロック12の電池モジュールの電圧検出時には、切り替えスイッチSW6～SW10をオンし、切り替えスイッチSW1～SW5をオフすることにより、電池ブロック12の各電池モジュールBAT06～BAT10の高位側の極の電位がデジタル信号に変換されて図示しないコントローラに出力され、このコントローラが減算処理により各電池モジュールBAT06～BAT10の電圧を検出する。

【0042】この実施例によれば、同一の電池ブロック

内の各分圧回路からモジュール電圧検出部に出力される分圧からなるモジュール電圧信号は、基準電位ラインの電位からなる共通電位を基準とする電位信号となるため各モジュール電圧検出部に印加する電源電圧を共用化することができるので、電源回路の簡素化を図ることができる上に、この場合におけるモジュール電圧検出部への入力信号電圧の増大を分圧回路の採用により低減するので、入力電圧の増大を抑止しつつ回路構成の簡素化を図ることができる。

【0043】更に、この実施例では、分圧回路の基準電位ライン側の抵抗素子R2、R4、R6、R8、R10はそれぞれ二つの分圧回路の一部を構成するので、抵抗素子数を減らすことができる。

【0044】

【実施例2】モジュール電圧検出回路ブロック4を構成するモジュール電圧検出部の他の例を図4に示す。

【0045】このモジュール電圧検出部は、差動電圧回路41と、その出力電圧をA/D変換するA/Dコンバータ42とからなる。他のモジュール電圧検出部も構成は同じである。各差動電圧回路41及び各A/Dコンバータ42には定電圧電源回路43から電源電圧VH、VLを供給されている。

【0046】電池ブロック11の電池モジュールの電圧検出時には、差動電圧回路41の－入力端は基準電位ライン3および切り替えスイッチSW21を通じて電池モジュールBAT05の低位側の極から基準電位VSSを受け取り、この時、切り替えスイッチSW22は開放されている。定電圧電源回路43から出力される電源電圧VLはこの基準電位VSSより低い電位にシフトされ、定電圧電源回路43から出力される電源電圧VHは、抵抗素子R1とR2との接続点の電位（分圧）VCHOよりも高い電位に設定されている。これにより、切り替えスイッチSW1～SW5をオンし、切り替えスイッチSW6～SW10をオフすることにより、電池ブロック11の各電池モジュールBAT01～BAT05の高位側の極の電位が各差動電圧回路41の＋入力端に入力されるので、その差をデジタル変換して図示しないコントローラに出力する。このコントローラは、減算処理により各電池モジュールBAT01～BAT05の電位を検出する。

【0047】同様に、電池ブロック12の電池モジュールの電圧検出時には、差動電圧回路41の－入力端は基準電位ライン3および切り替えスイッチSW22を通じて電池モジュールBAT10の低位側の極から基準電位VSSを受け取り、この時、切り替えスイッチSW21は開放されている。定電圧電源回路43から出力される電源電圧VLはこの基準電位VSSより低い電位にシフトされ、定電圧電源回路43から出力される電源電圧VHは、抵抗素子R11とR2との接続点の電位（分圧）VCHOよりも高い電位に設定されている。これによ

り、切り替えスイッチSW1～SW5をオフし、切り替えスイッチSW6～SW10をオンすることにより、電池ブロック12の各電池モジュールBAT06～BAT10の高位側の極の電位が各差動電圧回路41の+入力端に入力されるので、その差をデジタル変換して図示しないコントローラに出力する。このコントローラは、減算処理により各電池モジュールBAT06～BAT10の電位を検出する。

【0048】

【実施例3】本発明の組み電池の電圧検出装置の他の実施例を図2に示す部分回路図を参照して説明する。

【0049】この実施例の装置は、図1に示す実施例1の装置において、基準電位ライン3と切り替えスイッチSW21、SW22との間に更に分圧抵抗R21、R22を設けたものである。ただし、このようにすると、各抵抗素子間の抵抗比は変更を要する。

【0050】この実施例によれば、切り替えスイッチSW21、SW22のいずれか一方が短絡故障を起こした状態で他方の切り替えスイッチを導通させた場合でもこれら両切り替えスイッチSW21、SW22間を流れる短絡電流を規制でき、安全性を向上することができる。

【0051】

【実施例4】本発明の組み電池の電圧検出装置の他の実施例を図3に示す部分回路図を参照して説明する。

【0052】この実施例の装置は、図1に示す実施例1の装置において、分圧回路群2の奇数番号の抵抗素子からなるハイサイド抵抗素子群2aと、各切り替えスイッチSW1～SW10との接続順序を逆とし、すべての切り替えスイッチSW1～SW10、SW21、SW22を共通の回路基板5上に設け、更に、抵抗素子R2、R4、R6、R8、R10（本発明でいう基準電位ライン側の抵抗素子）を単一の抵抗素子Rcに置換したものである。更に、この実施例では、各切り替えスイッチSW1～SW10、SW21、SW22を通常のMOSトランジスタで構成している。

【0053】なお、電池ブロック11の各電池モジュールBAT01～BAT05の電圧検出に際しては、切り替えスイッチSW1～SW5を時間順次に導通させて、共通の抵抗素子Rcの両端の電位を検出し、それを単一のモジュール電圧検出部で検出する。また、電池ブロック12の各電池モジュールBAT06～BAT10の電圧検出に際しては、切り替えスイッチSW6～SW10を時間順次に導通させて、共通の抵抗素子Rcの両端の電位を検出し、それを上記と同じモジュール電圧検出部で検出する。なお、この実施例においても、図2に示す抵抗素子R21、R22の追加は可能である。

【0054】この実施例によれば、外部からの入力抵抗素子を通じて各切り替えスイッチSW1～SW10に入力されるので、静電気による電圧やその他のサージ電圧は上記抵抗素子で減衰され、これにより上記電圧に対

して切り替えスイッチSW1～SW10を良好に保護することができるという利点もある。

【0055】また、MOSトランジスタからなる切り替えスイッチSW1～SW10、SW21、SW22を駆動するための制御電圧を低電圧化でき、その耐圧（たとえばゲート耐圧）が小さい素子を用いることができるという大きな効果を奏することができる。これについて、図5を参照して更に説明する。

【0056】切り替えスイッチSW1はゲート電位Vgとそのソース電位Vsとの差である制御電圧Vgsで作動する。切り替えスイッチSW1がオフの場合にはソース電圧Vsは基準電位ライン3の電位に等しいので小さい制御電圧Vgsで切り替えスイッチSW1は作動することができ、更に、その導通後でも、ソース電圧Vsは抵抗素子R1とR2との分圧となって低いので、制御電圧Vgsが小さくても十分に切り替えスイッチSW1を駆動することができる。

【0057】これに対し、図1に示す切り替えスイッチSW1の配置では、その導通後には、ソース電圧Vsはほとんど電池モジュールBAT01の高位側の極の電位に等しくなるので、それよりも更に高いゲート電圧Vgを採用する必要があり、切り替えスイッチを構成する半導体スイッチの耐圧やチャンネル抵抗が格段に大きくなってしまふ。

【0058】更に、この実施例では、図3に示すように、各切り替えスイッチSW1～SW10の一端をそれらの共通の出力端51まで回路基板上の配線パターン更には1チップ化してチップ内配線とすることができるので、回路構成を極めて簡素化できるという利点がある。

【0059】なお、図1に示す実施例1の回路においても、切り替えスイッチSW1～SW10と奇数番号の抵抗素子とをこの実施例と同じく入れ替えることができ、切り替えスイッチSW1～SW10を構成する半導体スイッチの簡素化を図ることができ、更に、これら半導体スイッチを同一回路基板上に実装することにより配線の簡素化を図ることができる。

【0060】

【実施例5】本発明の組み電池の電圧検出装置の他の実施例を図6に示す回路図を参照して説明する。ただし、実施例1の回路と主要機能が共通する構成要素には同一符号を付す場合もあるものとする。

【0061】（構成）1は組み電池であり、最高位の電池ブロック11、次に最高位の電池ブロック12をもつ。電池ブロック11は5つの電池モジュールBAT01～BAT05を直列接続してなり、電池ブロック12は5つの電池モジュールBAT06～BAT10を直列接続してなる。

【0062】2は、ダイオードD1～D10及び抵抗素子R1～R20からなる分圧回路群21と、ダイオードD11～D15からなるクランプ回路22とからなる分



圧回路網である。分圧回路群211は、電池ブロック11用の第一群211と電池ブロック12用の第二群212とからなる。

【0063】第一群211は、ダイオードD1、抵抗素子R1及びR2を直列接続してなる分圧回路、ダイオードD2、抵抗素子R3及びR4を直列接続してなる分圧回路、ダイオードD3、抵抗素子R5及びR6を直列接続してなる分圧回路、ダイオードD4、抵抗素子R7及びR8を直列接続してなる分圧回路、ダイオードD5、抵抗素子R9及びR10を直列接続してなる分圧回路からなる。

【0064】同様に、第二群212は、ダイオードD6、抵抗素子R11及びR12を直列接続してなる分圧回路、ダイオードD7、抵抗素子R13及びR14を直列接続してなる分圧回路、ダイオードD8、抵抗素子R15及びR16を直列接続してなる分圧回路、ダイオードD9、抵抗素子R17及びR18を直列接続してなる分圧回路、ダイオードD10、抵抗素子R19及びR20を直列接続してなる分圧回路からなる。

【0065】第一群211の共通接続端2110及び第二群212の共通接続端2120はそれぞれ基準電位ライン3に接続されている。

【0066】第一群211の共通接続端2110は切り替えスイッチSW21を通じて電池ブロック11の最低電位端（共通端子）に接続され、同様に、第二群212の共通接続端2120は切り替えスイッチSW22を通じて電池ブロック12の最低電位端（共通端子）に接続されている。各分圧回路の高電位入力端は各電池モジュールBAT01～BAT10の高位側の極に接続され、第一群211の各分圧回路の低電位入力端は共通接続端2110に接続され、第二群212の各分圧回路の低電位入力端は共通接続端2120に接続されている。

【0067】各ダイオードD1～D10は各分圧回路の、分圧出力端と高電位入力端との間に介設され、各分圧出力端はモジュール電圧検出ブロック4内の各モジュール電圧検出部の入力端CH0～CH9に個別に接続されている。各モジュール電圧検出部はそれぞれ上記入力端と基準電位ライン3との間の電位差を検出するA/Dコンバータからなる。

【0068】（動作）電池ブロック11の電池モジュールの電圧検出時には、切り替えスイッチSW21がオン、切り替えスイッチSW22がオフとされる。

【0069】これにより、入力端CH0～CH4には、第一群211の分圧回路から電池ブロック11の各電池モジュールBAT01～BAT05の高位側電位と基準電位ライン3との間の電圧の分圧が印加され、これら分圧がA/D変換される。

【0070】この時、第二群212の各分圧回路の高電位入力端には電池ブロック12から負電位が印加されるが、この負電位は逆流防止ダイオードD6～D10によ

り阻止される。また、各逆流防止ダイオードD1～D5は各分圧回路を通じての電池モジュールの短絡を阻止する。

【0071】電池ブロック12の電池モジュールの電圧検出時には、切り替えスイッチSW21がオフ、切り替えスイッチSW22がオンとされる。

【0072】これにより、入力端CH5～CH9には、第二群212の分圧回路から電池ブロック12の各電池モジュールBAT06～BAT10の高位側電位と基準電位ライン3との間の電圧の分圧が印加され、これら分圧がA/D変換される。

【0073】この時、第一群211の各分圧回路の高電位入力端は、電池ブロック12の電圧の分圧だけ正方向にレベルシフトされるが、モジュール電圧検出ブロック4内の各モジュール電圧検出部の入力端CH0～CH4は、クランプ回路22をなす各ダイオードD11～D15により、VDD+ダイオードD11～D15の順方向電圧降下の合計にクランプされるので、入力端CH0～CH4から信号が入力されるモジュール電圧検出部の入力電圧が過大となることがない。

【0074】モジュール電圧検出回路ブロック4内では、各モジュール電圧検出部すなわちA/Dコンバータのデジタル出力電圧の減算処理により、各電池モジュールBAT01～BAT10の電圧が算出される。

【0075】この実施例によれば、同一の電池ブロック内の各分圧回路からモジュール電圧検出部に出力される分圧からなるモジュール電圧信号は、基準電位ラインの電位からなる共通電位を基準とする電位信号となるため各モジュール電圧検出部に印加する電源電圧を共用化することができるので、電源回路の簡素化を図ることができる上に、この場合におけるモジュール電圧検出部への入力信号電圧の増大を分圧回路の採用により低減するので、入力電圧の増大を抑止しつつ回路構成の簡素化を図ることができる。

【0076】更に、この実施例では、分圧回路網2はバイポーラ集積回路技術により作製されるので、回路構成を簡素化することができる。

【0077】

【実施例6】本発明の組み電池の電圧検出装置の他の実施例を図7に示す回路図を参照して説明する。ただし、実施例5の回路と主要機能が共通する構成要素には同一符号を付す場合もあるものとする。

【0078】（構成）図7に示す回路は、図6に示す分圧回路網2からクランプ回路22を省略し、その代わりに、分圧回路網2の各分圧出力端から出力される10個の信号電圧を、マルチプレクサ5のトランスファゲート51～60を個別に通じて5チャンネルの並列A/Dコンバータからなるモジュール電圧検出回路ブロック4の5つの入力端CH5～CH9に入力する回路構成を採用している。各トランスファゲート51～60はそれぞれ

小型のMOSトランジスタからなり、ワンチップのマルチプレクサ回路となっている。

【0079】（動作）電池ブロック11の電池モジュールの電圧検出時には切り替えスイッチSW21がオン、切り替えスイッチSW22がオフとされ、トランスファゲート51～55がオン、トランスファゲート56～60がオフされる。電池ブロック12の電池モジュールの電圧検出時には切り替えスイッチSW22がオン、切り替えスイッチSW21がオフとされ、トランスファゲート51～55がオフ、トランスファゲート56～60が

オンされる。

【0080】この実施例によれば、電池ブロック12の電池モジュールの電圧検出時に切り替えスイッチSW22がオン、切り替えスイッチSW21がオフとなつて、第一群211の分圧出力端の電位がレベルアップしても、トランスファゲート51～55がオフしているので、モジュール電圧検出回路ブロック4の入力端に悪影響を与えることがなく、その上、これらトランスファゲート51～60が入力信号電圧をマルチプレックスするので、モジュール電圧検出回路ブロックのA/Dコンバータの個数を減らすことができる。

【0081】（変形態様）この実施例の変形態様を図8に示す。

【0082】この変形態様では、図7において、モジュール電圧検出回路ブロック4及びマルチプレクサ5を変形したものであり、モジュール電圧検出回路ブロック4は一個のA/Dコンバータだけを持ち、マルチプレクサ5のトランスファゲート51～60は各分圧回路の分圧出力端をこの一個のA/Dコンバータの入力端CH9に接続する。

【0083】動作において、電池ブロック11の電圧検出では、切り替えスイッチSW21をオン、切り替えスイッチSW22をオフした状態でトランスファゲート51～55を順番にオンし、電池ブロック12の電圧検出では、切り替えスイッチSW22をオン、切り替えスイッチSW21をオフした状態でトランスファゲート56～60を順番にオンすればよい。

【0084】（変形態様）実施例5、6の変形態様を以下に説明する。

【0085】この変形態様では、切り替えスイッチSW21、SW22の両方がオンした場合に電池ブロック12が短絡されるのを防止するために、図9に示すようにこの短絡回路中に電流制限抵抗Rを配置したものである。特に、この電流制限抵抗Rを図9に示す位置に設けると、この電流制限抵抗Rは、電池ブロック11の電圧測定時における分圧回路小群21の主電流回路及び電池ブロック12の電圧測定時における分圧回路小群22の主電流回路から外れるので、分圧回路の検出精度を低下させることがない。また、この電流制限抵抗Rは正特性サーミスタのように高温時に高抵抗となる素子とすることができ、短絡電流を一層制限することができる。

【図面の簡単な説明】

【図1】本発明の組み電池の電圧検出装置の一例を示す回路図である。

【図2】本発明の組み電池の電圧検出装置の他例を示す回路図である。

【図3】本発明の組み電池の電圧検出装置の他例を示す回路図である。

【図4】モジュール電圧検出部の回路構成の一例を示すブロック図である。

【図5】切り替えスイッチの一例を示す回路図である。

【図6】本発明の組み電池の電圧検出装置の他例を示す回路図である。

【図7】本発明の組み電池の電圧検出装置の他例を示す回路図である。

【図8】本発明の組み電池の電圧検出装置の他例を示す回路図である。

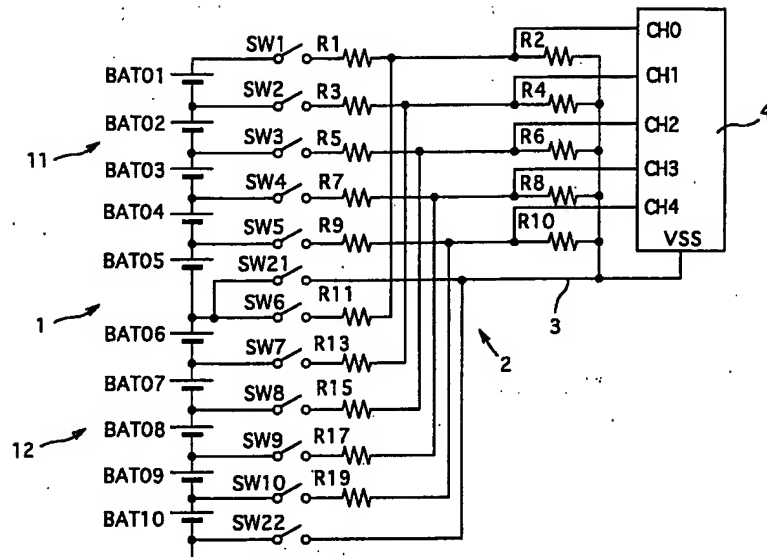
【図9】本発明の組み電池の電圧検出装置の他例を示す回路図である。

【符号の説明】

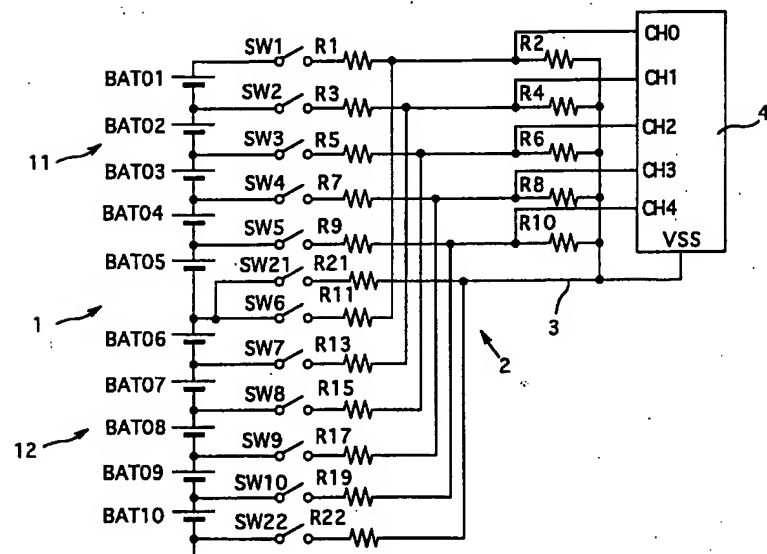
1は組み電池、2は分圧回路群（分圧回路網）、3は基準電位ライン、4はモジュール電圧検出回路ブロック（電圧検出回路）、R1～R10、R11、R13、R15、R17、R19は分圧回路の抵抗素子、SW1～SW10は切り替えスイッチ、SW21、SW22は切り替えスイッチ、11、12は電池ブロック、BAT01～BAT10は電池モジュール、22はクランプ回路



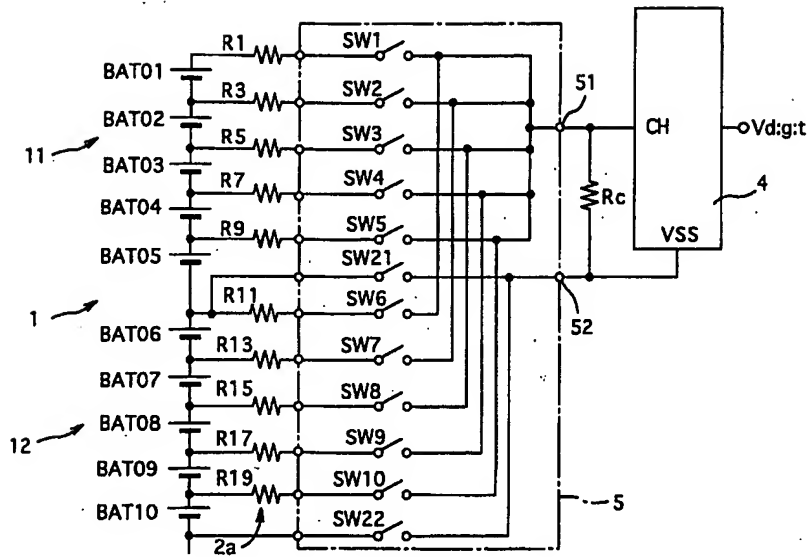
【図1】



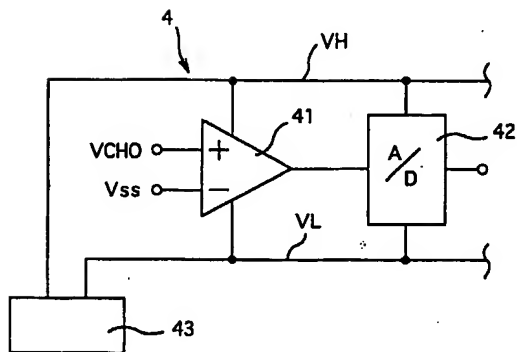
【図2】



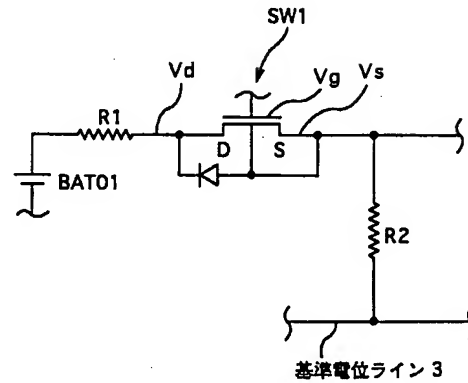
【図3】



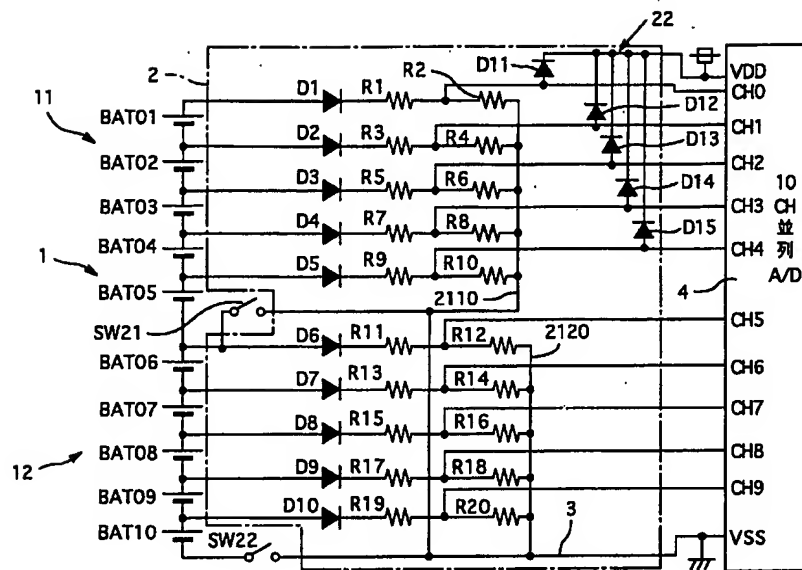
【図4】



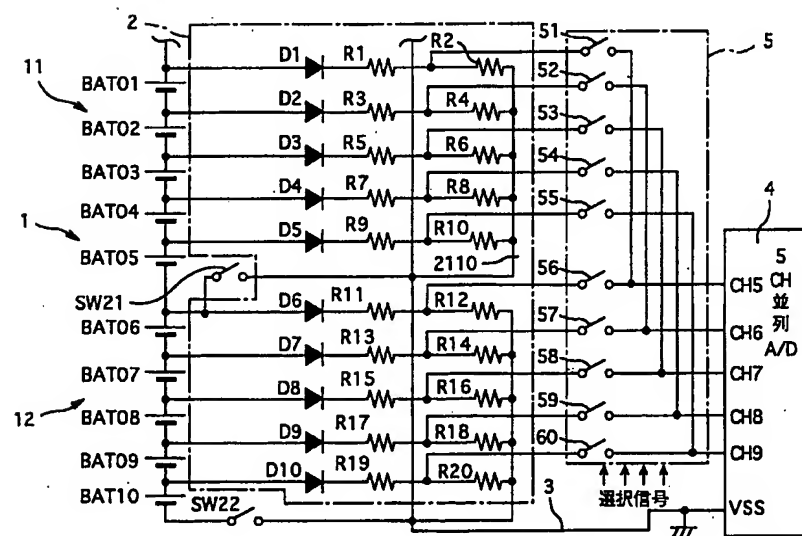
【図5】



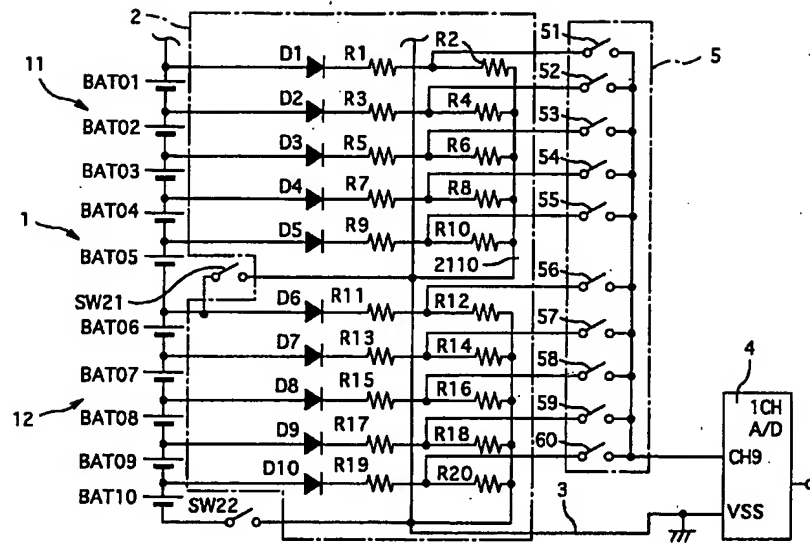
【図6】



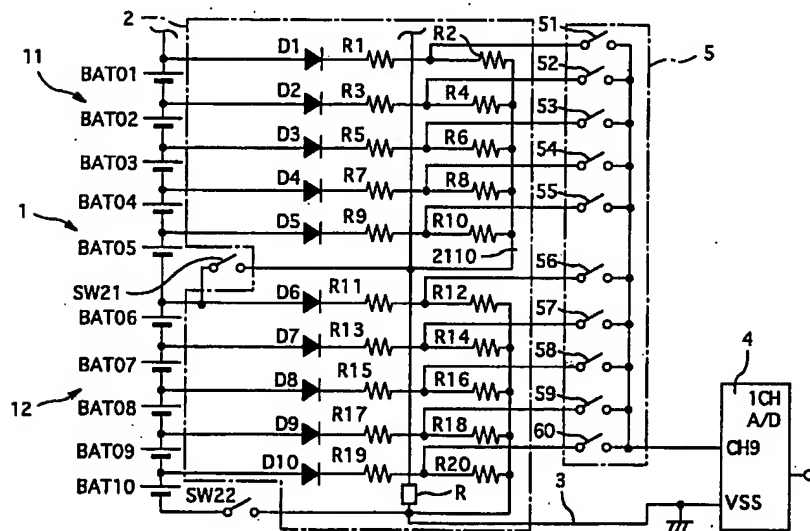
【図7】



【図 8】



【図 9】



# PATENT ABSTRACTS OF JAPAN

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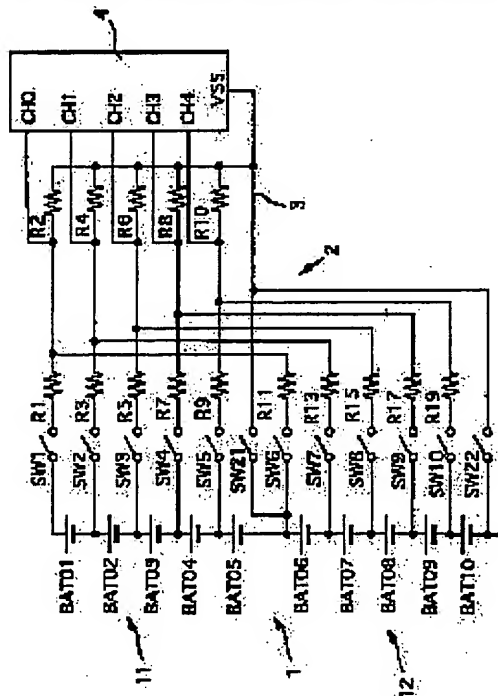
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(30)Priority

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## (54) VOLTAGE DETECTING DEVICE OF BATTERY SET



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a voltage detecting device capable of inhibiting a reduction of a detection accuracy and a safety, while realizing with a simple circuit constitution. SOLUTION: Common terminals comprising lowest position terminals of a battery block 11 are independently connected to one end of the large number of voltage-dividing circuits, in which a plurality of resistance elements R1-R10 are connected in series through a standard potential line 3. The other ends of the respective voltage-dividing circuits are connected to high position side terminals of respective battery modules BAT01-BAT05, except for the common terminals respectively. Of a plurality of resistance elements of the respective voltage-dividing circuits, a voltage drop of the resistance elements R2, R4, R6, R8, R10 on the standard potential line side is detected. The resistance elements R2, R4, R6, R8, R10 on the standard potential line side are also used as resistance elements on the standard potential line side of a voltage-dividing circuit which detects the potential of the

R10 on the standard potential line side are also used as resistance elements on the standard potential line side of a voltage-dividing circuit which detects the potential of the

battery modules BAT06-BAT10 of a battery block 12.

**\* NOTICES \***

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. \*\*\*\* shows the word which can not be translated.
3. In the drawings, any words are not translated.

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**CLAIMS**

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[Claim(s)]

[Claim 1] In the electrical-potential-difference detection equipment which comes to carry out two or more series connections of the cell block which comes to carry out two or more series connections of the battery module, constructs it, and detects the terminal voltage of each aforementioned battery module by the module electrical-potential-difference detecting element from a cell and which it constructs and is a cell The common terminal which consists of the high end of said cell block or a terminal like the minimum It connects with the common end connection which is one edge each of the partial pressure circuit of a large number which come to carry out series connection of two or more resistance elements, respectively through reference potential Rhine. The other end of each aforementioned partial pressure circuit By connecting with the terminal of each aforementioned battery module except said common terminal, respectively, it is characterized by said module electrical-potential-difference detecting element detecting the voltage drop of said resistance element of said reference potential line side among said two or more resistance elements of each of said partial pressure circuit, constructs, and is electrical-potential-difference detection equipment of a cell.

[Claim 2] Said common terminal of said second cell block for a start [ according to claim 1 ] which constructs and adjoins in potential in the electrical-potential-difference detection equipment of a cell It connects with said common reference potential Rhine through a changeover switch, respectively. Said each partial pressure circuit By having the changeover switch by which the series connection was carried out to said two or more resistance elements, respectively, it is characterized by said resistance element of said reference potential line side of said first cell block serving as said resistance element of said reference potential line side of said second cell block, constructs, and is electrical-potential-difference detection equipment of a cell.

[Claim 3] It is characterized by supposing [ in / construct, and said each partial pressure circuit has the changeover switch according to claim 1 or 2 by which the series connection was carried out to said two or more resistance elements, respectively in the electrical-potential-difference detection equipment of a cell, and / said each partial pressure circuit ] that it is common, and constructs, and said resistance element of said reference potential line side is electrical-potential-difference detection equipment of a cell.

[Claim 4] By constructing and interposing said each changeover switch in the electrical-potential-difference detection equipment of a cell among said two or more resistance elements of said partial pressure circuit, it is characterized by the thing [ that said two or more changeover switches are accumulated by the same circuit module ] according to



claim 2 or 3, constructs, and is electrical-potential-difference detection equipment of a cell.

[Claim 5] By connecting said common terminal of said second cell block to said common reference potential Rhine through a changeover switch, respectively for a start

[ according to claim 1 ] which constructs and adjoins in potential in the electrical-potential-difference detection equipment of a cell, it is characterized by said each partial pressure circuit having the antisuckback diode by which series connection was carried out to said two or more resistance elements, respectively, constructs, and is electrical-potential-difference detection equipment of a cell.

[Claim 6] It is characterized by having the clamping circuit which inhibits the potential of the partial pressure outgoing end of said partial pressure circuit connected to said battery module belonging to said cell block by the side of the high order of said cell blocks of the pair by which adjoined [ in / construct and / the electrical-potential-difference detection equipment of a cell ] in potential, and the series connection was carried out according to claim 5 below on predetermined level, constructs, and is electrical-potential-difference detection equipment of a cell.

[Claim 7] It constructs, is characterized by connecting the partial pressure outgoing end of two or more of said partial pressure circuits to the input edge of said one electrical-potential-difference detector through a mutually different signal changeover switch according to claim 5 in the electrical-potential-difference detection equipment of a cell, constructs, and is electrical-potential-difference detection equipment of a cell.

## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is constructed and relates to the electrical-potential-difference detection equipment of a cell.

[0002]

[Description of the Prior Art] JP,5-64377,A detected and constructed the module electrical potential difference of two or more battery modules which consists of many cells of a cascade connection format by the electrical-potential-difference detection module, respectively, and has proposed the electrical-potential-difference detection equipment of a cell.

[0003]

[Problem(s) to be Solved by the Invention] However, as mentioned above, circuitry became large-scale [ detecting each module electrical potential difference according to an individual in many differential mold electrical-potential-difference detectors ], and the improvement was required in respect of costs, power consumption, a tooth space, and dependability.

[0004] The thing which can be realized by simple circuitry, this invention being made in view of the above-mentioned trouble, and inhibiting the fall of detection precision or safety and for which it constructs and the electrical-potential-difference detection equipment of a cell is offered is set as the purpose.

[0005]

[Means for Solving the Problem] By this invention indicated to claim 1 constructing,

according to the electrical-potential-difference detection equipment of a cell, high pressure constructs and a cell comes to carry out two or more series connections of the cell block which comes to carry out two or more series connections of the battery module. As a battery module, you may be with one cell, and series connection of two or more cells may be carried out.

[0006] Especially with this configuration, the common terminal which consists of the high end of a cell block or a terminal like the minimum is connected to the end of the partial pressure circuit of a large number which come to carry out series connection of two or more resistance elements, respectively according to an individual through reference potential Rhine, the other end of each partial pressure circuit is connected to the terminal of each battery module except a common terminal, respectively, and the voltage drop of the resistance element of a reference potential line side is detected among two or more resistance elements of each partial pressure circuit. If it does in this way, since the module voltage signal which consists of a partial pressure outputted to a module electrical-potential-difference detecting element from each partial pressure circuit within the same cell block turns into a potential signal on the basis of the common potential which consists of potential of reference potential Rhine, subsequent circuit processing becomes easy and an error can perform little module electrical-potential-difference detection by simple circuitry.

[0007] Furthermore, if it explains, since the potential of each battery module will be detected in one cell block on the basis of the highest potential or the minimum potential of this cell block, the terminal voltage of each battery module is called for as difference of each detected battery-module potential. Since supply voltage impressed to each module electrical-potential-difference detecting element can be common-use-sized rather than it detects the potential difference (terminal voltage) of each battery module according to an individual if it does in this way, the effect of dispersion in the line voltage variation which can attain simplification of a power circuit and is outputted from each power circuit is also small.

[0008] However, by the method which asks for the potential of each battery module by the potential difference from a common reference potential for every cell block mentioned above, and computes the potential difference of each battery module by subtraction of the potential of each battery module, the potential of the battery module which is distant from reference potential Rhine of a cell block serves as the high pressure, several times, for example, several 10V, of the battery-module potential difference, and needs proof-pressure increase of the input section of a module electrical-potential-difference detecting element for detection of such a high voltage. On the other hand, with this configuration, since the potential of each battery module is pressured partially in the partial pressure circuit on the basis of the potential (reference potential) of above-mentioned reference potential Rhine, input voltage of a module electrical-potential-difference detecting element can be made into usual level called 5V, and it becomes possible to constitute a module electrical-potential-difference detecting element from a general-purpose circuit element.

[0009] According to the configuration according to claim 2, claim 1 publication constructs and it sets to the electrical-potential-difference detection equipment of a cell. Further Said common terminal of the second cell block is connected to said common reference potential Rhine through a changeover switch (reference potential changeover

switch) for a start which adjoins in potential, respectively. Each partial pressure circuit has the changeover switch (module electrical-potential-difference changeover switch) by which the series connection was carried out to two or more resistance elements, respectively, and the resistance element of the reference potential line side of the first cell block serves as the resistance element of the criteria \*\*\*\*\* line side of the second cell block.

[0010] If it does in this way, since the potential of a cell block of the pair which adjoins in potential is detectable with the change of a changeover switch, while being able to reduce by half the number of module electrical-potential-difference detecting elements, the need number of the resistance element of a partial pressure circuit can be reduced sharply, and contraction of a circuit scale can be aimed at.

[0011] Furthermore, since the short-circuit current which flows via both [ these ] changeover switches even if it turns on the remaining module electrical-potential-difference changeover switch after one of two or more of the connected module electrical-potential-difference changeover switches has carried out closed-circuit failure is controlled by the resistance element, it is excellent in safety. That is, while resistance of a partial pressure circuit does so the operation effectiveness according to claim 1, the short-circuit current reduction effectiveness can also do it so.

[0012] According to the configuration according to claim 3, it constructs, each partial pressure circuit has further the changeover switch according to claim 1 or 2 by which the series connection was carried out to two or more resistance elements in the electrical-potential-difference detection equipment of a cell, respectively, and the resistance element of a reference potential line side is made common in each partial pressure circuit.

[0013] If it does in this way, since the required number of the resistance element of a module electrical-potential-difference detecting element and a partial pressure circuit is further reducible, the further circuit degradation is realizable.

[0014] Since according to the configuration according to claim 4 claim 2 or 3 publications construct, each changeover switch is further interposed among two or more resistance elements of a partial pressure circuit in the electrical-potential-difference detection equipment of a cell and two or more changeover switches are accumulated by the same circuit module, simplification of circuitry can be attained.

[0015] That is, since the terminal by the side of the anti-battery module of each changeover switch can be connected inside the terminal by the side of at least one anti-battery module of other changeover switches, and a circuit module when interposing each changeover switch among two or more resistance elements of a partial pressure circuit, the external number of wiring Rhine and its connection activity can be reduced sharply, and a changeover switch circuit can be simplified.

[0016] For a start which this invention indicated to claim 5 constructs, and adjoins in potential according to the electrical-potential-difference detection equipment of a cell, the common terminal of the second cell block is connected to common reference potential Rhine through a changeover switch, respectively, and each partial pressure circuit has the antisuckback diode connected with two or more resistance elements (minute piezo-resistance) at the serial. An electrical-potential-difference detector detects the potential of the partial pressure outgoing end of each resistance partial pressure circuit which belongs substantially the low voltage edge of the battery module of the minimum potential of the cell block which should be measured to this cell block as criteria. At this time, the

common terminal of the cell block which should be measured is connected to reference potential Rhine with a changeover switch only at the time of measurement.

[0017] If it does in this way, the following operation effectiveness will be done so.

[0018] According to this configuration, since antisuckback diode is interposed for every resistance partial pressure circuit between a battery module and a resistance partial pressure circuit, it is not necessary to carry out series connection of the transfer switch for every partial pressure circuit like a configuration according to claim 2, and circuit manufacture becomes easy.

[0019] That is, this antisuckback diode can prevent the circulation (short circuit) current which circulates through the circuit which consists of two partial pressure circuits of arbitration and 1 thru/or two or more battery modules by the transfer switch prepared for every partial pressure circuit like a configuration according to claim 3. antisuckback diode is markedly boiled as compared with a transfer switch, is cheap and can also omit the closing motion control circuit.

[0020] Furthermore, it explains.

[0021] Since this transfer switch is connected to a partial pressure circuit and a serial, the current of a partial pressure circuit flows. As everyone knows, electrical-potential-difference change of a battery module is small, needs to measure this small electrical-potential-difference change in a low noise extremely, for this reason, needs to make small the resistance element (that on resistance when [ And ] carrying out series connection of the changeover switch to it) of a partial pressure circuit, and needs to make those resistance noises small.

[0022] However, it is the so-called transfer switch, and a transfer switch needs to secure pressure-proofing of insurance top both directions, respectively, creating with a bipolar technique is difficult for it, and it cannot but produce it with an MOS technique. However, integration with the large-sized MOS transistor as a transfer switch and the low resistance element (usually produced with a bipolar technique) of a partial pressure circuit is not easy.

[0023] On the other hand, there is little number of a transfer switch required of this configuration, and since the configuration which uses antisuckback diode for short-circuit current inhibition is adopted, the partial pressure circuit and this antisuckback diode of low resistance can be easily integrated with a bipolar integrated circuit technique.

[0024] In addition, according to this circuitry, an electrical-potential-difference detector measures a signal level equal to  $x$  (forward voltage drop  $\Delta V$  of terminal voltage  $V$ -antisuckback diode of battery module) division ratio, but since the amount of forward voltage drops of antisuckback diode can be beforehand known if a current value and temperature are known, the measured value by dispersion in the voltage drop of antisuckback diode can be amended using various hardware or software.

[0025] According to the configuration according to claim 6, it has the clamping circuit which inhibits the potential of the partial pressure outgoing end of the partial pressure circuit connected to the battery module belonging to the cell block by the side of the high order of said cell blocks of the pair by which constructed, and adjoined still in potential and the series connection was carried out in the electrical-potential-difference detection equipment of a cell according to claim 5 below on predetermined level.

[0026] If it does in this way, it is not necessary to increase the available voltage of the module electrical-potential-difference detecting element which the output of the electrical

potential difference which hung the division ratio of a partial pressure circuit on a part for the electrical potential difference of the cell block by the side of lower order of the resistance partial pressure circuit of the cell block by the side of a high order does not improve, and detects the electrical potential difference by actuation of a clamping circuit in case the potential of the partial pressure outgoing end of the resistance partial pressure circuit connected to the battery module belonging to the cell block by the side of lower order is measured.

[0027] In addition, diode, reference diode, etc. can be used as this clamping circuit.

[0028] According to the configuration according to claim 7, it connects [ in / construct and / the electrical-potential-difference detection equipment of a cell ] with the input edge of one electrical-potential-difference detector through the signal changeover switch according to claim 5 with which the partial pressure outgoing ends of further two or more partial pressure circuits differ mutually.

[0029] If it does in this way, in case the potential of the partial pressure outgoing end of the partial pressure circuit connected to the battery module belonging to the cell block by the side of lower order will be measured Since the above-mentioned signal changeover switch is wide opened even if the output of the electrical potential difference which hung the division ratio of a partial pressure circuit on a part for the electrical potential difference of the cell block by the side of lower order of the resistance partial pressure circuit of the cell block by the side of a high order improves It is not necessary to increase the input signal pressure-proofing of a module electrical-potential-difference detecting element which detects the potential of the partial pressure outgoing end of the partial pressure circuit connected to the battery module belonging to the cell block by the side of a high order, and the above-mentioned clamping circuit can be omitted.

[0030] Furthermore, moreover, this signal changeover switch can be used as the so-called multiplexer, and has the advantage that the number of a module electrical-potential-difference detecting element can be reduced.

[0031] in addition, although this circuitry needs both antisuckback diode and a signal changeover switch, the changeover switches by which the series connection was carried out to a partial pressure circuit which indicates this signal changeover switch claim 2 may essentially differ, and that on resistance may be alike and high. That is, that this signal changeover switch should just only transmit the potential of the partial pressure outgoing end of a partial pressure circuit to the input edge of a module electrical-potential-difference detecting element, that on resistance is satisfactory also as several +k ohms or more, many signal changeover switches can be easily constituted from an MOS IC, and since an on resistance value still of this level inhibits surge noise electrical-potential-difference invasion at the input edge of a module electrical-potential-difference detecting element, it is desirable.

[0032] On the other hand, the changeover switch by which the series connection was carried out to the partial pressure circuit must form the on resistance into \*\*\*\* resistance markedly, in order to inhibit a resistance noise electrical potential difference, it is difficult the changeover switch to accumulate many changeover switches, and, moreover, dispersion in on resistance also needs to reduce it.

[0033]

[Embodiment of the Invention] Hereafter, the following examples explain the suitable mode of this invention to a detail. However, as for this invention, it is natural that it is not

limited to the configuration of the following example and can constitute using a replaceable well-known circuit.

[0034]

[Example 1] It explains with reference to the partial circuit diagram of this invention constructing and showing one example of the electrical-potential-difference detection equipment of a cell in drawing 1.

[0035] 1 constructs, is a cell and comes to carry out series connection of a total of the cell block 11 of the high end, and four cell blocks which include the cell block 12 of the high end next. However, illustration of the remaining cell block is omitted. The cell block 11 comes to carry out the series connection of the five battery modules BAT01-BAT05, and the cell block 12 comes to carry out the series connection of the five battery modules BAT06-BAT10.

[0036] 2 is resistance elements R1-R11 and a partial pressure circuit group which consists of R13, R15, R17, and R19, and R1, R2 and R3, R4 and R5, R6 and R7, R8 and R9, R10 and R11, R2 and R13, R4 and R15, R6 and R17, and R8, R19 and R10 constitute the partial pressure circuit, respectively. It connects with the minimum potential edge of the cell block 11 through reference potential Rhine 3 and a changeover switch SW21, and one edge each of resistance elements R2, R4, R6, R8, and R10 (resistance element of the reference potential line side as used in the field of this invention) is connected to the minimum potential edge of the cell block 12 through reference potential Rhine 3 and a changeover switch SW22. Moreover, each other end of resistance elements R2, R4, R6, R8, and R10 (resistance element of the reference potential line side as used in the field of this invention) is connected to the pole by the side of the high order of each battery module of the cell block 11 through resistance elements R1, R3, R5, R7, and R9 and changeover switches SW1-SW5. Furthermore, each other end of resistance elements R2, R4, R6, R8, and R10 (resistance element of the reference potential line side as used in the field of this invention) is connected to the pole by the side of the high order of each battery module of the cell block 12 through resistance elements R11, R13, R15, R17, and R19 and changeover switches SW6-SW10.

[0037] Each changeover switches SW1-SW10, and SW21 and SW22 consist of a photograph MOS transistor, are driven with the lightwave signal from LED which meets, respectively, and are opened and closed.

[0038] 4 is a module electrical-potential-difference detection block, builds the module electrical-potential-difference detecting element of five channels in juxtaposition inside, and has detected the voltage drop of resistance elements R2, R4, R6, R8, and R10 (resistance element of the reference potential line side as used in the field of this invention) according to an individual. The above-mentioned module electrical-potential-difference detecting element consists of an A/D converter, respectively. The A/D converter of the format which changes many input signals serially, of course may be used.

[0039] This A/D converter changes into a digital signal the electrical-potential-difference difference of the partial pressure and reference potential VSS which are inputted from each above-mentioned partial pressure circuit. In an example, although this A/D converter has two or more comparators which compare the partial pressure inputted as the reference voltage generating circuit which creates various kinds of larger reference voltage as a reference potential than it, and each created reference voltage in a reference potential VSS, and the digital signal generating circuit which changes into a digital signal



the signal outputted from a comparator, detail explanation is omitted.

[0040] At the time of electrical-potential-difference detection of the battery module of the cell block 11, the changeover switch SW22 is wide opened for the A/D converter in the reference potential VSS through reference potential Rhine 3 and a changeover switch SW21 at reception and this time from the pole by the side of the lower order of a battery module BAT05. By turning on changeover switches SW1-SW5, and turning off changeover switches SW6-SW10 by this, it is outputted to the controller which the potential of the pole by the side of the high order of each battery modules BAT01-BAT05 of the cell block 11 is changed into a digital signal, and is not illustrated, and this controller detects the electrical potential difference of each battery modules BAT01-BAT05 by subtraction processing.

[0041] Similarly, at the time of electrical-potential-difference detection of the battery module of the cell block 12, by turning on changeover switches SW6-SW10, and turning off changeover switches SW1-SW5, it is outputted to the controller which the potential of the pole by the side of the high order of each battery modules BAT06-BAT10 of the cell block 12 is changed into a digital signal, and is not illustrated, and this controller detects the electrical potential difference of each battery modules BAT06-BAT10 by subtraction processing.

[0042] According to this example, the module voltage signal which consists of a partial pressure outputted to a module electrical-potential-difference detecting element from each partial pressure circuit within the same cell block Since it becomes a potential signal on the basis of the common potential which consists of potential of reference potential Rhine and supply voltage impressed to each module electrical-potential-difference detecting element can be common-use-ized Since increase of the input signal electrical potential difference to the module electrical-potential-difference detecting element which can attain simplification of a power circuit upwards and can be set in this case is reduced by adoption of a partial pressure circuit, simplification of circuitry can be attained inhibiting increase of input voltage.

[0043] Furthermore, in this example, since the resistance element R2 of the reference potential line side of a partial pressure circuit, R4, R6, and R8 and R10 constitute a part of two partial pressure circuits, respectively, a resistance element number can be reduced.

[0044]

[Example 2] Other examples of the module electrical-potential-difference detecting element which constitutes the module electrical-potential-difference detector block 4 are shown in drawing 4.

[0045] This module electrical-potential-difference detecting element consists of a differential voltage circuit 41 and A/D converter 42 which carries out A/D conversion of that output voltage. Other module electrical-potential-difference detecting elements of a configuration are the same. Supply voltage VH and VL is supplied by each differential voltage circuit 41 and each A/D converter 42 from the constant-voltage-power-supply circuit 43.

[0046] At the time of electrical-potential-difference detection of the battery module of the cell block 11, the changeover switch SW22 is wide opened for - input edge of the differential voltage circuit 41 in the reference potential VSS through reference potential Rhine 3 and a changeover switch SW21 at reception and this time from the pole by the side of the lower order of a battery module BAT05. The supply voltage VH which the

supply voltage VL outputted from the constant-voltage-power-supply circuit 43 is shifted to potential lower than this reference potential VSS, and is outputted from the constant-voltage-power-supply circuit 43 is set as potential higher than the potential (partial pressure) VCHO of a node with resistance elements R1 and R2. Since the potential of the pole by the side of the high order of each battery modules BAT01-BAT05 of the cell block 11 is inputted into + input edge of each differential voltage circuit 41 by turning on changeover switches SW1-SW5, and turning off changeover switches SW6-SW10 by this, it outputs to the controller which carries out digital conversion of the difference, and does not illustrate it. This controller detects the potential of each battery modules BAT01-BAT05 by subtraction processing.

[0047] Similarly, at the time of electrical-potential-difference detection of the battery module of the cell block 12, the changeover switch SW21 is wide opened for - input edge of the differential voltage circuit 41 in the reference potential VSS through reference potential Rhine 3 and a changeover switch SW22 at reception and this time from the pole by the side of the lower order of a battery module BAT10. The supply voltage VH which the supply voltage VL outputted from the constant-voltage-power-supply circuit 43 is shifted to potential lower than this reference potential VSS, and is outputted from the constant-voltage-power-supply circuit 43 is set as potential higher than the potential (partial pressure) VCHO of a node with resistance elements R11 and R2. Since the potential of the pole by the side of the high order of each battery modules BAT06-BAT10 of the cell block 12 is inputted into + input edge of each differential voltage circuit 41 by turning off changeover switches SW1-SW5, and turning on changeover switches SW6-SW10 by this, it outputs to the controller which carries out digital conversion of the difference, and does not illustrate it. This controller detects the potential of each battery modules BAT06-BAT10 by subtraction processing.

[0048]

[Example 3] It explains with reference to the partial circuit diagram of this invention constructing and showing other examples of the electrical-potential-difference detection equipment of a cell in drawing 2.

[0049] The equipment of this example forms the partial pressure resistance R21 and R22 further in the equipment of the example 1 shown in drawing 1 between reference potential Rhine 3 and changeover switches SW21 and SW22. However, if it does in this way, the resistance ratio between each resistance element will require modification.

[0050] According to this example, even when either of the changeover switches SW21 and SW22 makes it flow through the changeover switch of another side where closed-circuit failure is caused, the short-circuit current which flows between both [ these ] the changeover switches SW [ SW21 and ] 22 can be regulated, and safety can be improved.

[0051]

[Example 4] It explains with reference to the partial circuit diagram of this invention constructing and showing other examples of the electrical-potential-difference detection equipment of a cell in drawing 3.

[0052] High side resistance elements 2a which consists of a resistance element of the odd number of the partial pressure circuit group 2 in the equipment of the example 1 which shows the equipment of this example to drawing 1, Make reverse connection sequence with each changeover switches SW1-SW10, and all the changeover switches SW1-SW10, and SW21 and SW22 are prepared on the common circuit board 5. Furthermore,

resistance elements R2, R4, R6, R8, and R10 (resistance element of the reference potential line side as used in the field of this invention) are permuted by the single resistance element Rc. Furthermore, this example constitutes each changeover switches SW1-SW10, and SW21 and SW22 from the usual MOS transistor.

[0053] In addition, on the occasion of electrical-potential-difference detection of each battery modules BAT01-BAT05 of the cell block 11, time amount sequential is made to flow through changeover switches SW1-SW5, the potential of the both ends of the common resistance element Rc is detected, and it is detected by the single module electrical-potential-difference detecting element. Moreover, on the occasion of electrical-potential-difference detection of each battery modules BAT06-BAT10 of the cell block 12, time amount sequential is made to flow through changeover switches SW6-SW10, the potential of the both ends of the common resistance element Rc is detected, and it is detected by the same module electrical-potential-difference detecting element as the above. In addition, also in this example, the addition of the resistance elements R21 and R22 shown in drawing 2 is possible.

[0054] According to this example, since the input from the outside is inputted into each changeover switches SW1-SW10 through a resistance element, the electrical potential difference by static electricity and other surge voltage are decreased by the above-mentioned resistance element, and also have the advantage that changeover switches SW1-SW10 can be protected good to the above-mentioned electrical potential difference by this.

[0055] Moreover, -izing of the control voltage for driving the changeover switches SW1-SW10 which consist of an MOS transistor, and SW21 and SW22 can be carried out [ low battery ], and the proof pressure (for example, gate proof pressure) can do so the big effectiveness that a small component can be used. This is further explained with reference to drawing 5.

[0056] A changeover switch SW1 operates with the control voltage Vgs which is the difference of the gate potential Vg and its source potential Vs. Since the source electrical potential difference Vs is equal to the potential of reference potential Rhine 3 when a changeover switch SW1 is OFF, a changeover switch SW1 can operate with the small control voltage Vgs, and further, also after the flow, the source electrical potential difference Vs turns into a partial pressure with resistance elements R1 and R2, and since it is low, even if control voltage Vgs is small, a changeover switch SW1 can fully be driven.

[0057] on the other hand, it is necessary to adopt the gate voltage Vg still higher than it, and since the source electrical potential difference Vs becomes almost equal to the potential of the pole by the side of the high order of a battery module BAT01, in. arrangement of the changeover switch SW1 shown in drawing 1, after the flow, the pressure-proofing and channel resistance of a solid state switch which constitute a changeover switch will be markedly alike, and will become large.

[0058] Furthermore, in this example, as shown in drawing 3, since 1 chip can be formed and it can consider as wiring in a chip, there are a circuit pattern on the circuit board and also an advantage that circuitry can be simplified extremely, to those common outgoing ends 51 about the end of each changeover switches SW1-SW10.

[0059] In addition, also in the circuit of the example 1 shown in drawing 1, changeover switches SW1-SW10 and the resistance element of an odd number can be replaced as

well as this example, simplification of the solid state switch which constitutes changeover switches SW1-SW10 can be attained, and simplification of wiring can be further attained by mounting these solid state switches on the same circuit board.

[0060]

[Example 5] It explains with reference to the circuit diagram of this invention constructing and showing other examples of the electrical-potential-difference detection equipment of a cell in drawing 6 . However, also when it gives the same sign to the component in which the circuit and main functions of an example 1 are common, it considers as a certain thing.

[0061] (Configuration) 1 constructs, is a cell and has the cell block 12 of the high end in the cell block 11 of the high end, and a degree. The cell block 11 comes to carry out the series connection of the five battery modules BAT01-BAT05, and the cell block 12 comes to carry out the series connection of the five battery modules BAT06-BAT10.

[0062] 2 is a voltage divider network which consists of a partial pressure circuit group 21 which consists of diodes D1-D10 and resistance elements R1-R20, and a clamping circuit 22 which consists of diodes D11-D15. The partial pressure circuit group 21 consists of the first group 211 for cell block 11, and the second group 212 for cell block 12.

[0063] The first group 211 consists of a partial pressure circuit which comes to carry out series connection of the partial pressure circuit which comes to carry out series connection of the partial pressure circuit which comes to carry out series connection of the partial pressure circuit which comes to carry out series connection of diode D1 and the resistance elements R1 and R2, diode D2, and the resistance elements R3 and R4, diode D3, and the resistance elements R5 and R6, diode D4, and the resistance elements R7 and R8, diode D5, and the resistance elements R9 and R10.

[0064] The partial pressure circuit where similarly the second group 212 comes to carry out series connection of diode D6 and the resistance elements R11 and R12, Diode D7, the partial pressure circuit which comes to carry out series connection of the resistance elements R13 and R41, It consists of a partial pressure circuit which comes to carry out series connection of the partial pressure circuit which comes to carry out series connection of the partial pressure circuit which comes to carry out series connection of diode D8 and the resistance elements R15 and R16, diode D9, and the resistance elements R17 and R18, diode D10, and the resistance elements R19 and R20.

[0065] The common end connection 2110 of the first group 211 and the common end connection 2120 of the second group 212 are connected to reference potential Rhine 3, respectively.

[0066] The common end connection 2110 of the first group 211 is connected to the minimum potential edge (common terminal) of the cell block 11 through a changeover switch SW21, and the common end connection 2120 of the second group 212 is similarly connected to the minimum potential edge (common terminal) of the cell block 12 through the changeover switch SW22. The high potential input edge of each partial pressure circuit is connected to the pole by the side of the high order of each battery modules BAT01-BAT10, the low voltage input edge of each partial pressure circuit of the first group 211 is connected to the common end connection 2110, and the low voltage input edge of each partial pressure circuit of the second group 212 is connected to the common end connection 2120.

[0067] Each diodes D1-D10 are interposed between the partial pressure outgoing ends and high potential input edges of each partial pressure circuit, and each partial pressure outgoing end is connected to the input edges CH0-CH9 of each module electrical-potential-difference detecting element within the module electrical-potential-difference detection block 4 according to the individual. Each module electrical-potential-difference detecting element consists of an A/D converter which detects the potential difference between the above-mentioned input edge and reference potential Rhine 3, respectively.

[0068] (Actuation) At the time of electrical-potential-difference detection of the battery module of the cell block 11, it is supposed that a changeover switch SW21 has ON and an off changeover switch SW22.

[0069] Thereby, the partial pressure of the electrical potential difference between the high order side potential of each battery modules BAT01-BAT05 of the cell block 11 and reference potential Rhine 3 is impressed to the input edges CH0-CH4 from the partial pressure circuit of the first group 211, and A/D conversion of these partial pressures is carried out to them.

[0070] Although negative potential is impressed to the high potential input edge of each partial pressure circuit of the second group 212 from the cell block 12 at this time, this negative potential is prevented by the antisuckback diodes D6-D10. Moreover, each antisuckback diodes D1-D5 prevent the short circuit of the battery module which leads each partial pressure circuit.

[0071] At the time of electrical-potential-difference detection of the battery module of the cell block 12, a changeover switch SW21 is set to OFF, and a changeover switch SW22 is set to ON.

[0072] Thereby, the partial pressure of the electrical potential difference between the high order side potential of each battery modules BAT06-BAT10 of the cell block 12 and reference potential Rhine 3 is impressed to the input edges CH5-CH9 from the partial pressure circuit of the second group 212, and A/D conversion of these partial pressures is carried out to them.

[0073] Although, as for the high potential input edge of each partial pressure circuit of the first group 211, the level shift only of the partial pressure of the electrical potential difference of the cell block 12 is carried out in the forward direction at this time The input edges CH0-CH4 of each module electrical-potential-difference detecting element within the module electrical-potential-difference detection block 4 With each diodes D11-D15 which make a clamping circuit 22, since it is clamped by the sum total of the forward voltage drop of the VDD+ diodes D11-D15, the input voltage of the module electrical-potential-difference detecting element into which a signal is inputted does not become excessive from the input edges CH0-CH4.

[0074] Within the module electrical-potential-difference detector block 4, the electrical potential difference of each battery modules BAT01-BAT10 is computed by subtraction processing of each module electrical-potential-difference detecting element, i.e., the digital output electrical potential difference of an A/D converter.

[0075] According to this example, the module voltage signal which consists of a partial pressure outputted to a module electrical-potential-difference detecting element from each partial pressure circuit within the same cell block Since it becomes a potential signal on the basis of the common potential which consists of potential of reference potential Rhine and supply voltage impressed to each module electrical-potential-difference

detecting element can be common-use-ized Since increase of the input signal electrical potential difference to the module electrical-potential-difference detecting element which can attain simplification of a power circuit upwards and can be set in this case is reduced by adoption of a partial pressure circuit, simplification of circuitry can be attained inhibiting increase of input voltage.

[0076] Furthermore, in this example, since a voltage divider network 2 is produced by the bipolar integrated circuit technique, circuitry can be simplified.

[0077]

[Example 6] It explains with reference to the circuit diagram of this invention constructing and showing other examples of the electrical-potential-difference detection equipment of a cell in drawing 7 . However, also when it gives the same sign to the component in which the circuit and main functions of an example 5 are common, it considers as a certain thing.

[0078] (Configuration) The circuitry which inputs the signal level of ten pieces which omits a clamping circuit 22 from the voltage divider network 2 shown in drawing 6 , instead is outputted from each partial pressure outgoing end of a voltage divider network 2 into five input edges CH5-CH9 of the module electrical-potential-difference detector block 4 which consists the transfer gates 51-60 of a multiplexer 5 of a juxtaposition A/D converter of five channels through an individual exception is used for the circuit shown in drawing 7 . Each transfer gates 51-60 consist of a respectively small MOS transistor, and serve as a multiplexer circuit of a one chip.

[0079] (Actuation) At the time of electrical-potential-difference detection of the battery module of the cell block 11, it is supposed that a changeover switch SW21 has ON and an off changeover switch SW22, and ON and the transfer gates 56-60 are turned off for the transfer gates 51-55. At the time of electrical-potential-difference detection of the battery module of the cell block 12, it is supposed that a changeover switch SW22 has ON and an off changeover switch SW21, and OFF and the transfer gates 56-60 are turned on for the transfer gates 51-55.

[0080] Even if according to this example a changeover switch SW22 becomes off [ ON and a changeover switch SW21 ] at the time of electrical-potential-difference detection of the battery module of the cell block 12 and the potential of the partial pressure outgoing end of the first group 211 improves Since it does not have a bad influence on the input edge of the module electrical-potential-difference detector block 4 since the transfer gates 51-55 turn off, and these transfer gates 51-60 moreover carry out the multiplexer of the input signal level The number of the A/D converter of a module electrical-potential-difference detector block can be reduced.

[0081] (Deformation mode) The deformation mode of this example is shown in drawing 8 .

[0082] In this deformation mode, in drawing 7, the module electrical-potential-difference detector block 4 and a multiplexer 5 are transformed, the module electrical-potential-difference detector block 4 has only the A/D converter of a piece, and the transfer gates 51-60 of a multiplexer 5 connect the partial pressure outgoing end of each partial pressure circuit to the input edge CH9 of the A/D converter of this piece.

[0083] What is necessary is to turn on the transfer gates 51-55 in order, where ON and a changeover switch SW22 are turned off for a changeover switch SW21, and just to turn on the transfer gates 56-60 in order by electrical-potential-difference detection of the cell



block 12, in actuation, at electrical-potential-difference detection of the cell block 11, where ON and a changeover switch SW21 are turned off for a changeover switch SW22. [0084] (Deformation mode) The deformation mode of examples 5 and 6 is explained below.

[0085] In this deformation mode, when both changeover switches SW21 and SW22 turn on, in order to prevent that the cell block 12 connects too hastily, as shown in drawing 9, the current-limiting resistance R is arranged all over this short circuit. If this current-limiting resistance R is especially formed in the location shown in drawing 9, since it will separate from this current-limiting resistance R from the principal current circuit of the partial pressure circuit small group 21 at the time of the amplitude measurement of the cell block 11, and the principal current circuit of the partial pressure circuit small group 22 at the time of the amplitude measurement of the cell block 12, detection precision of a partial pressure circuit is not reduced. Moreover, like a positive thermistor, at the time of an elevated temperature, this current-limiting resistance R can be used as the component used as high resistance, and can restrict a short-circuit current further.

## DESCRIPTION OF DRAWINGS

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### [Brief Description of the Drawings]

[Drawing 1] It is the circuit diagram of this invention in which constructing and showing an example of the electrical-potential-difference detection equipment of a cell.

[Drawing 2] It is the circuit diagram of this invention in which constructing and showing the other examples of the electrical-potential-difference detection equipment of a cell.

[Drawing 3] It is the circuit diagram of this invention in which constructing and showing the other examples of the electrical-potential-difference detection equipment of a cell.

[Drawing 4] It is the block diagram showing an example of the circuitry of a module electrical-potential-difference detecting element.

[Drawing 5] It is the circuit diagram showing an example of a changeover switch.

[Drawing 6] It is the circuit diagram of this invention in which constructing and showing the other examples of the electrical-potential-difference detection equipment of a cell.

[Drawing 7] It is the circuit diagram of this invention in which constructing and showing the other examples of the electrical-potential-difference detection equipment of a cell.

[Drawing 8] It is the circuit diagram of this invention in which constructing and showing the other examples of the electrical-potential-difference detection equipment of a cell.

[Drawing 9] It is the circuit diagram of this invention in which constructing and showing the other examples of the electrical-potential-difference detection equipment of a cell.

### [Description of Notations]

1 -- constructing -- a cell and 2 -- a partial pressure circuit group (voltage divider network) and 3 -- reference potential Rhine and 4 -- a module electrical-potential-difference detector block (electrical-potential-difference detector), R1-R10, and R11, R13, R15, R17 and R19 -- the resistance element of a partial pressure circuit, and SW1-SW10 -- a changeover switch, and SW21 and SW22 -- a changeover switch, and 11 and 12 -- a cell block, and BAT01-BAT10 -- a battery module and 22 -- a clamping circuit

## DRAWINGS

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[Drawing 1]

[Drawing 2]

[Drawing 3]

[Drawing 4]

[Drawing 5]

[Drawing 6]

[Drawing 7]

[Drawing 8]

[Drawing 9]

